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ABSTRACT

This paper examines the notion of whether computers can provide teachers with the necessary tools to alter the constraints of the traditional classroom and allow for constructivism and independent learning. The study was carried out at Methodist Ladies' College, a girls' school in Melbourne, Australia; information was collected through teacher interviews, classroom observation, questionnaires, attendance at meetings and professional development activities and small group discussions. Independent learning was found to have a strong chance of succeeding because the generous provision of resources was matched with the demands of the expanded educational goals. Traditional structures, which appeared to inhibit innovation in its early stages, were both challenged and changed as a result of the interplay between goals and resources; however, the environment into which the innovation was introduced was often at odds with teacher attitudes. Overall, it was found that technology may have the potential to free teachers from the moment by moment demands of whole class teaching, enabling them to concentrate on challenging students and catering to students as individuals. (AEF)

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FREE AT LAST? TEACHERS, COMPUTERS AND INDEPENDENT LEARNING.

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In this paper, we would like to examine the notion of whether computers can provide teachers with the necessary tools to alter the constraints of the traditional classroom, thereby allowing students and teachers the freedom to pursue the type of learning which educationalists have so often put forward as an ideal.

Are teachers merely "coping with computers" or are computers relieving teachers of some important constraints, thus freeing teachers and students to pursue more meaningful and more personalized learning goals? Assuming that quality in student learning is the aim, one may ask whether an education that is strongly supported by computer technology, has a better chance of achieving these goals than that supported by earlier technological innovation.

The research upon which this paper is based took place in a school that adopted the educational philosophy of constructionism and independent learning. However, at the same time that the school embraced this philosophy, it also made an extensive commitment to computer technology. This was not by chance. The school leadership saw the computers as strongly resourcing the change. As a result they were emphasized as a central component of the innovation, which was referred to as "Sunrise".

Context of the study

This paper examines whether the use of the computers has changed the context of teachers' work in such a way that the goals of constructionism and independent learning are more attainable. The research centres around a four year study at Methodist Ladies' College, a girls' school in Melbourne, Australia.

In carrying out this ethnographic study, the primary researcher interviewed Sunrise teachers, observed classes, administered questionnaires, attended meetings and professional development activities, and organised small group discussions. In 1992 she also taught in the program, in order to gain a deeper insight into the experiences of teachers coping with the extensive changes.

With a student population of over 2000, MLC would rank as one of the largest girls' schools in Australia, and one of the most technologically innovative. Most students own and use a personal

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notebook computer for their studies. Ownership of a notebook computer has been a requisite for students entering the school in Year 5 or above since 1993.

The technological innovativeness of a school, however, can not be judged by the mere ownership of computers. It is not having computers that is important, it is how they are used. At MLC the computers are utilized as part of a constructionist philosophy which values student centredness, and the capacity of students to create and construct their own learning. In Year 7, the students use the program LogoWriter (although this year they have moved to using the newer version Microworlds), which allows them to program the computer to carry out a myriad of tasks. The students construct in many ways using the computer, such as linking it up to robotic constructions (Lego Logo) or using it to create and illustrate new concepts and their own interpretations of them.

Independent learning: Then and now

The notion of student-centred activity in which students create their own learning within a flexible and supportive learning environment, is not new. The goals of open learning in the 1960s, for example, had much in common with the ideals of independent learning, as outlined in MLC policy statements. Both focus on students and more purposeful, independent learning, emphasizing exploratory behaviour, play, direct experience and the concretization of concepts.

Ian Westbury, in 1973, described an open learning environment as one where "children learn and develop intellectually not only at their own rate but in their own style . . ." (p. 110) - a premise shared by those who advocate constructionism and independent learning at MLC. The value of collaboration is another shared emphasis, as is the positive value of mistakes. The student-centred focus is supported by the notion of teacher as creator of an environment in which children can pursue activities that are meaningful to them.

It is interesting to note the similarities and consistency between the educational aspirations of constructionism, independent learning and open learning. If after twenty years, a core of educationalists has again reached the same conclusions as to what is important in children's learning, then perhaps it is worth looking at why such principles are so difficult to implement and sustain successfully. A key question for the research was whether the new technology adopted by MLC would provide a means by which the goals and values, inherent in these philosophies, could be realised more effectively than in the past.

The demands and constraints of the conventional classroom

In his article "Conventional Classrooms, "Open" Classrooms and the Technology of Teaching," Westbury put forward a rationale for the failure of "open learning" in the '60s and '70s. Westbury argued that the classroom is an environment "that contains demands and constraints that are inherent in its nature, given existing goals, structures and resources" (p. 100). He further stated that the "interaction" between demands and constraints limits the possibilities for teachers to manipulate their environment. Thus, innovations that do not address the demands and constraints are doomed to failure, because they do not take into account the functional reality of the classroom and the day-to day pressures on teachers.

Westbury contends that in any classroom teachers experience four basic demands or pressures:

a) to present and cover a body of material (content);
b) to engender mastery of that material by his or her students;
c) to create interest and to secure compliance to the demands of the learning situation; and
d) to manage the class (discipline).

The conventional classroom is a "technology" that has the capacity to help teachers meet these demands. In meeting them, a teacher's resources may be restricted to a few textbooks and a blackboard, or they may be extensive and rich. Regardless of this, if any innovation or reform threatens the teacher's perception of his/her ability to meet these demands it is unlikely to be adopted. Westbury argues that many teachers gave up on open education as an innovation because they felt no longer able to meet these fundamental demands. Control over classroom demands seemed to be slipping from their grasp. Although their educational aspirations may have changed, the resources and structures available to teachers to achieve them had not. As a result, teachers reverted to the technology of the conventional classroom structure as a coping strategy.

Westbury suggested that the key to any fundamental change in the nature of teachers' work was the invention of engaging resources for students or "educational toys" that reassured teachers that the basic demands of coverage, mastery, interest and discipline were being met, thereby freeing them for more personalised teaching.

Following through Westbury's description of the open classroom, which contains many similarities with MLC's independent learning philosophy, it is important to ask whether the "goals, structures and resources" at MLC have altered in ways that remove traditional constraints and create a new learning environment. Have personal notebook computers, for example, provided sufficient flexibility and richness of learning experience for students, thus freeing the teacher from some important classroom constraints? Do teachers regard the goals and values that were espoused in the open education movement as more attainable and realistic? Are teachers and administrators prepared to alter or modify the classroom structures in support of these ideals?

From many interviews over four years, frequent observation, and experience teaching within the program, it was discovered that much had changed within the Sunrise classrooms. The changes were slow to occur. They often emerged after periods of dissatisfaction and discord, but changes had happened. These changes are summarized below, using Westbury's criteria of goals, structures and resources, as they relate to the demands and constraints of the classroom. In the MLC case, it became increasingly evident that these categories were interrelated and that the computer technology was instrumental in both introducing and supporting the changes and in reshaping the goals and structures.

Goals

Some of the goals relating to constructionism and independent learning have already been outlined. However, it is important to note how these goals were interpreted in the context of the classroom by both teachers and students at MLC.

The main implication of "independent learning" is that students are responsible for their own learning. Although a framework for study is provided, students have choices as to what aspects of a topic they wish to explore, the resources they will use to investigate the topic, and the final presentation of their work. Students are encouraged to set their own short term goals, to plan class time in order to attain those goals, and to select and utilise resources from those available.

Direct teacher instruction to the class as a whole is infrequent, and student-centred projects are emphasized. The teacher's role is altered, broadening to include many new functions, as will be discussed under "resources" below.

The constructionist philosophy, strongly promoted by the principal, David Loader, centres around the belief that students

will learn more effectively if they set their own problems, build their own knowledge and express ideas through media that foster direct experience. Computer programs, such as LogoWriter and Microworlds were developed along these philosophical lines and were selected by MLC because they contributed to a learning environment that was compatible with the goals of the Sunrise program.

In the Sunrise classrooms at MLC, many of these goals have been realised in practice, but the extent to which this has happened is variable, depending upon the individual teacher's educational values and ability to implement them. Also relevant is the degree of emphasis generated by that teacher's subject department. It is evident that the philosophy is gaining strength in classrooms as time passes, due in part to the large investment in professional development in the school, and the balance of pressure and support which is constantly influencing both individuals and departments.

In order to provide an example of how the Sunrise goals are implemented, a brief description of a mathematics classroom in operation follows.

Students begin a unit with a pre-test, which identifies existing knowledge. The test is marked, using a computer program developed by the Mathematics Co-ordinator, and then a personal program of tasks is set, again using the computer, which will assist the student in acquiring or extending skills. The result is a class where thirty students are working on individualized programs. Specific Logo projects are introduced, and students have a degree of latitude within these to explore and present concepts of interest. Post-tests assess the understanding of students when work is completed.

As can be expected, students may race ahead, no longer being forced to work at the same pace as everyone else. The school accepts this and allows students to continue working at their own pace, assisting students to study work in future year levels if they are capable of doing so (ie. Year 7 students completing Year 8 Mathematics units)

Mathematics does not allow quite the same amount of scope in choice of topic, except in projects, that one may find, for example, in Humanities, but the above description does illustrate the independence of the students and the freeing of both them and the teacher from traditional classroom constraints. Of course, such a system, whilst removing traditional constraints may also intensify demands upon individuals.

Within this mathematics environment, the computers are used both to allow flexibility in the pace and scope of tasks, and to illustrate concepts which may prove to be outside the direct experience of students.

Westbury reported that one of the challenges of open learning was to make mathematical concepts accessible to children (p.116). With LogoWriter students can directly experience a concept and manipulate it in a way that creates and reinforces understanding. In Year 7 at MLC, students are encouraged to use LogoWriter to explore and expand upon their knowledge of fractions. One teacher spoke of a student who programmed the computer in such a way that fractions could not be added together unless their denominators were that same. This student also created a program where other students could add shapes (representing fractions) together until the fractions formed a whole. At that point, the screen was programmed to darken, indicating that a whole number had been reached. Often simple concepts can be illustrated in powerful ways. Such visual demonstrations where the child can manipulate the tools and experiment with outcomes can contribute towards strong constructionist learning.

Used in this way, the technology assists the teacher to realise several of the Sunrise goals and to meet Westbury's classroom demands. Students are covering content, working independently, at their own pace, and with materials which allow them to experiment and be creative with important concepts. "Control" and "interest" become less important as classroom issues for Sunrise teachers, as students tend to become more engaged in directing their own learning. The teacher is, however, still responsible for monitoring the progress of each student, a task which takes on new complexity with thirty individualized programs in each class.

Structures

In the Mathematics classroom, the learning environment has changed significantly for both students and teachers. A second example from a Humanities classroom illustrates how many of the traditional structures have altered since the advent of Sunrise at MLC.

Perhaps the very existence of Humanities which, at MLC in Year 7, is an integration of English, History, Geography and Biblical Studies, provides an example of how one of the structures - individual subject-based study - has altered. Because of this integration, longer blocks of time have been formed, allowing classes to work for two or three 45 minute periods without interruption. The integration provides for two teachers to share

the class. Although timetabled individually with the class, the teachers work together in planning, monitoring and assessing student work. This innovation has challenged quite dramatically some of the original classroom structures which were found to be limiting: short blocks of time, disjointed subject focus and the isolation of teachers.

The change in structures (integration of subjects, blocking of time and the teaming of teachers) supports the goals of independent learning and constructionism. Students have longer blocks of time in which to plan work. There is greater flexibility of time in which to negotiate tasks with a teacher and a wider choice, as to areas of interest, is offered.

In Westbury's paper, an examination is made of the practice of recitation or lecturing in class. It is described as popular because it allows teachers to "cope with the demands of the classroom setting" whilst giving them control over student activity, allowing for content coverage and, through drill and practice, some mastery of facts. (p. 103) In an MLC Humanities classroom there is very little recitation by teachers. How then do they cope with Westbury's four demands upon teachers (control, coverage, interest and mastery)?

The issue of class control immediately alters when student-centred activity takes place. The highly interactive nature of LogoWriter contributes to an environment where class control is rarely an issue due to strong engagement with learning tasks. These tasks may not always be computer activities. In a study of Egypt, students were also engaged in turning their classroom into a temple and making models of Egyptian artifacts.

The computers are of great value in connecting isolated tasks and allowing an avenue for individual and creative expression. Tasks which may have been isolated in traditional classrooms such as map drawing, story telling and the writing up of research areas may all be meshed together in a LogoWriter activity. In one class students were observed creating their own interactive maps of the Nile, which allowed their audiences to embark upon a discovery tour of Egypt. The locations chosen, the information provided and the story line were all the choice of each student. Teachers did not insist upon the total coverage of all set areas; they allowed students to select topics of interest and to explore these in greater depth than would have occurred in the traditional classroom. The nature of "coverage" in MLC Humanities classrooms has altered to allow for more individual choice and greater depth.

Maintaining student attention ceases to be a strong focus of Sunrise teachers, as students have greater ownership of their tasks. The phenomenon of students working through recess or into lunchtime has become commonplace.

Much of the drudgery of classroom work evaporates as word processors, CD Roms and interactive programs free students from laborious re-writing, copying of notes and the expression of ideas in a highly prescribed format. When areas of study are also injected with student choice and flexibilty of pace and focus, students as well as teachers experience a freeing from traditional classroom constraints.

One very tangible structure, which has been altered in response to the Sunrise innovation, is the physical environment of the classroom itself. Complete renovation of existing classrooms has allowed students to have access to a large shared work area, separated from the classroom by a glass wall. Students do not have to work at their own desk. According to the requirements of the task being carried out, students may work at a desk, on the floor, at large tables in the common work area, or in the library. It is accepted that the teacher cannot directly supervise students in several locations at the same time, and so students are trusted to stay on task. As the library has many staff, and the common work area is open to several classrooms, students are rarely out of sight of a staff member, although they may not be directly supervised by their own teacher. It could be suggested that Year 7 students may not fully respond to such trust, but observations and comments from the Sunrise teachers interviewed indicated that students did remain on task most of the time. In fact, teachers reported that students remain on task more consistently than under the previous traditional system.

Many of the traditional structures have altered in the Sunrise classes. Assessment of students is non-competitive, and usually comprises detailed comments as to work embarked upon and completed. Working processes, skills diplayed and understandings gained are emphasized. Standardised achievement tests are not used. Being an independent school, MLC has the autonomy to decide upon assessment measures, with the exception of Year 11 and 12 students whose coursework and assessment is directly related to the demands of the Victorian Certificate of Education, which is used to decide upon tertiary entrance. However, at the Junior Secondary level at MLC, in which the Sunrise school is located, there is relative freedom in deciding upon assessment and reporting procedures.

As a result of changes to classroom structures, teaching demands have altered substantially. As has been mentioned, teachers do not have to supervise students directly all of the time. Recitation teaching is limited, and teachers have many more opportunities to work with individual students. Teachers have been freed from many of the constraints relating to whole class control and the maintenance of student interest. However, new

management and assessment concerns emerge as students pursue individualised options, changing the nature of teachers' work quite considerably.

Resources

Although the introduction of computers has relieved teachers of some constraints, they initially created considerable concerns and upheaval for teachers. There was much initial reticence among teachers who, unfamiliar with the technology, entered classes where every student had a notebook computer on the desk. Directives to incorporate their use in the classroom were clear and classes were run, outside school hours, to instruct teachers in the use of LogoWriter. The introduction of support personnel, technicians, financial incentives to purchase computers and numerous professional development classes provided support, but in some ways added to the pressure. The change for many teachers was daunting. For the first year or two in particular, teachers were simply learning "how to cope with computers".

With experience, however, teachers came to see the computers as less of a threat and more of an opportunity. Some saw great advantages in teaching certain concepts, such as fractions, through LogoWriter. Others, such as the Mathematics Co-ordinator, developed a program which would correct work and set new tasks for individual students. Some teachers appreciated the capability of the software to make thinking processes more transparent, as exemplified by student programming. LogoWriter seemed to inject new flexibility into tasks, and the students' level of motivation increased as a result.

Students could often pursue tasks more independently with the aid of the computer, although the interaction between class members has been more extensive. Computer use seemed to enable students to pursue more individual options, and allowed greater variation in the presentation of ideas and responses. For example, when the primary researcher set an assignment entitled "Who Kidnapped the Principal?", she envisaged students writing police files and newspaper reports with their computers. One student created a discovery game in which clues were hidden and suspects presented. The program opened with a musical introduction which convinced the other teachers in the staff room that this teacher was highly innovative. However, at this stage she had no idea how the student had created the effects, as her programming expertise was not as well developed as the student's. Such situations occurred frequently in the early stages of Sunrise and were quite refreshing - students displaying skills which teachers had not yet developed.

Although it is important not to imply that computers and LogoWriter are the main focus of the Sunrise innovation at MLC, their presence has contributed to change. One mathematics teacher attributes changes in pedagogy to experiences where working with computers demanded new responses:

> *Computers change the nature of the traditional classroom dramatically. . . they force people to see the need to change. Computers have forced people to change their teaching strategies, forced people to admit that they are no longer the ultimate source of information and forced people to consider how to cope with individual differences, because unless teachers do that they won't cope. For example, you may have the class working on some very challenging computer programming when 15 students become "stuck" simultaneously. You can't deal with them as a group because they are working on different things. And so you are forced then into adopting what is a peer tutoring environment. The outcome of this is really fantastic. The spin off is that once teachers develop these strategies (in relation to learning with the computers) they adopt these strategies even when the computers are not being used. Computers create a situation where to "succeed" you have no option but to change. (Paul 21/2/95)*

The notion of technology as a catalyst for change is relevant here, but the changes to which this teacher is referring go beyond the notion of gaining new skills or being seen to be keeping up with the times. Paul is arguing that working with computers and LogoWriter allows the students to work at their own pace, according to their own needs and their own abilities. It also means accepting that thirty students in a classroom may be working on thirty different things at any one time. For a teacher to cope with such a situation requires new strategies, and Paul argues that the use of the computers has forced teachers to adopt these new strategies.

The adoption of peer tutoring is one example of the significant changes in many MLC classrooms. As teachers became students of technology, it was soon apparent that everyone in the classroom was now a learner. The teacher may not always have the expertise to help, or she may be already occupied helping someone else. The adage "ask three before me" quickly became adopted, freeing teachers from the role as sole "expert" and

establishing a learning environment where sharing became the norm. New ideas flow quickly in Sunrise classrooms, prompting many teachers to re-name the innovation "inter-dependent learning".

Certain behaviours have become valued increasingly in Sunrise classes: risk-taking, perseverance, initiative, creativity and group problem-solving. Not that these do not exist in traditional classrooms, but in Sunrise classes they become an intrinsic part of daily classroom processes. Computer programming, a common activity in Year 7, requires similar behaviours from students thus reinforcing the validity of changed teacher and student roles.

It appears that the use of the computers in the MLC context facilitated the altering of classroom structures along the lines of independent learning and constructionism, but also then forced teachers to adopt strategies which further reinforced the philosophy, simply in order to cope with the new demands. It became harder and harder to teach along traditional lines, with the new resources. Once the snowball began rolling, it simply picked up speed - to resist it became more difficult than going along with the set direction.

It is important to state that this change required MLC teachers to be highly competent educators, with a great deal of expertise in a number of areas. Not only was subject mastery still a strong requirement, MLC teachers had to develop high level capabilities with the computer technology. Effective communication with students was a vital prerequisite, as well as the ability to adapt to constantly shifting classroom demands. It was recognised from an early stage that if the MLC Sunrise program was to succeed, it needed a team of accomplished, expert teachers. This does not mean that all teachers had to be totally aligned to the innovation from its inception. I asked one MLC teacher who, three years before, had been very reticent about the innovation, whether computers had helped to free teachers from traditional classroom constraints:

> *Yes they do. Now I am a facilitator in the classroom. I am free to focus on one child, one area at a time. The girls can work independently, they can learn from each other. I am free to extend the more able, and to support the slower ones.*
>
> *Visitors are often amazed to watch students who really do work, even when the teacher is not supervising them. The students are trusted to work and they do work. If there is a problem, you can get on to it straight away. With computers, students can do their*

one thing. Microworlds is more intuitive than LogoWriter - even I can do it. The students can be creative and they love it. Half the students have colour screens. There is a CD Rom nearby. We have Internet. As teachers, we are looking for different things, we have different ways of doing things. Computers let everyone do more, they provide flexibility, they allow for extension. You still need discussion, group work, drama - they (the computers) must be balanced with other activities. But while independent learning can be achieved without computers, it is more achievable with them. I think that students can work independently much earlier with computers, gain the skills at a younger age. Computers make it easier to reach the goals. And computers hold their attention - students can be very creative with them. (Sharon, 21/2/95)

Conclusion

The interrelationship between goals, structures, and resources is extremely relevant to any understanding of the MLC innovation and its impact upon traditional classroom demands and constraints. In this particular case, independent learning has a strong chance of succeeding, in fact is succeeding, because the relationship between goals, structures and resources has been recognized in the school's implementation planning. The generous provision of relevant resources has been matched with the demands of the expanded educational goals. Traditional structures, which appeared to inhibit the innovation in its early stages, were both challenged and changed as a result of the interplay between the goals and resources.

Success stories, such as MLC, come at a price. The initial pressure on innovators was extreme, the environment into which the innovation was introduced was often at odds with the aims of teachers. Some staff felt that the demands to acquire extensive computing skills were excessive. Some teachers could not relate to the constructionist ideas behind the changes or the changes themselves. Some teachers left, some teachers avoided the change, some teachers complained loudly, and some teachers tried to change the constraints.

The initial study for this project documented the changes relating to the innovation from 1990 to 1993. Conclusions made then reflected the view that there was still a long way to go. The constraints of the classroom and the curriculum were very evident, and the demands upon teachers were very high. Many issues were being dealt with, but many conflicts between the old and the new were not yet resolved.

It was pleasing therefore in 1995 to return to the school and to see that some of the constraints were being addressed. The physical environment of Year 7 classes had changed dramatically, providing students with more flexible, open work areas. Technological support had been extended even further, and the software itself had been updated, making it more attractive and accessible to students and staff alike. Attempts had been made to rationalise the content of each syllabus, there was an admission that some of the old content could go and that new ideas and methods had proven their worth. A specific program had been written for MLC teachers to aid report writing and to make it uniform across the school. Problems were being ironed out and many more teachers were now feeling comfortable with the new environment and the new strategies.

If a school has high quality teachers, strong leadership, shared goals and compatible structures and resources for achieving those goals, then extensive change is possible. However, there are degrees of acceptance in each of these categories. MLC certainly had high quality teachers and strong leadership. It also had access to appropriate resources, but not all staff embraced the usage of those resources to the same degree, and not all staff fully understood why the changes themselves were so desirable and important to others. A uniform sharing of the philosophy was not apparent during those first few years of the research for many reasons. Firstly, the change was young, and it takes time for shared understandings to emerge. There was also a lot to cope with in those early days, and for many the computers seemed to demand unreasonable attention. Often it is necessary to work with an innovation, before one really understands it. As Fullan (1992) states:

> *It seems that most people do not discover new understandings until they have delved into something . . . In many cases, changes in behaviour precede rather than follow changes in beliefs. (p. 25)*

Westbury claimed in 1973 that "Individualisation is rarely, if ever, an option in conventional classrooms because of inadequate resources of both time and materials." (p. 107) At MLC individualisation is not only a goal of Sunrise classes, it is a reality. The issue of "time" has been addressed in Humanities classes, but the most significant contribution in the area of "materials" is clearly notebook computers and LogoWriter. Back in 1973 Westbury hinted at the possibilities of "educational toys" which could motivate and be, to a degree, "self-instructing and . . . self-

managing." (p. 117) He concluded that "The ideology of open education articulates goals which the conventional school can not address." Goals were limited by classroom constraints and the demands of teachers' work to address "mastery, coverage, management and affect" (p. 119).

This paper illustrates a case where several of the goals of independent learning have been met because classroom constraints were addressed and the nature of teachers' work did change. It illustrates a case where a technology may at last have the potential to free teachers from the moment by moment demands of whole class teaching. It may enable them to concentrate finally on challenging and catering for students as individuals. It is too early to be sure. The conditions supporting change at MLC were generous in comparison with most schools. MLC does not represent the cheap alternative.

Quality teachers were clearly more, not less, important to the achievement of such expanded educational goals. The computers were a technology for supporting, not supplanting good teaching.

"Sunrise" is an appropriate title for the program operating at MLC. Perhaps a new day has dawned in education: one which seems to be responsive to the needs of both teachers and students.

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